

# Why study the water and energy cycle?...

Variations in greenhouse gases, aerosols,  
and solar activity force changes in climate...

...but, consequences of climate change are  
realized through the water cycle.

Thus, we must characterize, understand, and  
predict variations in the global water cycle.

**Water and Energy** is linked to all 12 Science Application Themes.



Carbon  
Management



Water  
Management



Agricultural  
Competitiveness



Public Health



Homeland  
Security



Energy Forecasting



Coastal  
Management



Community Growth



Aviation Safety



Disaster  
Preparedness



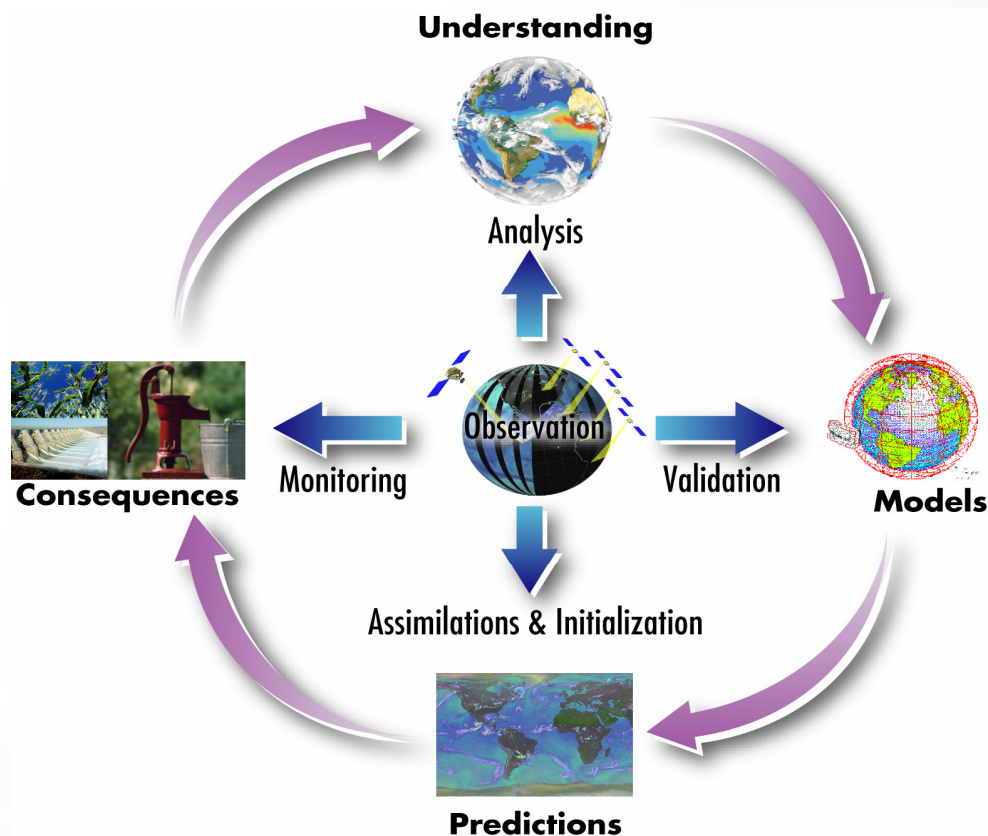
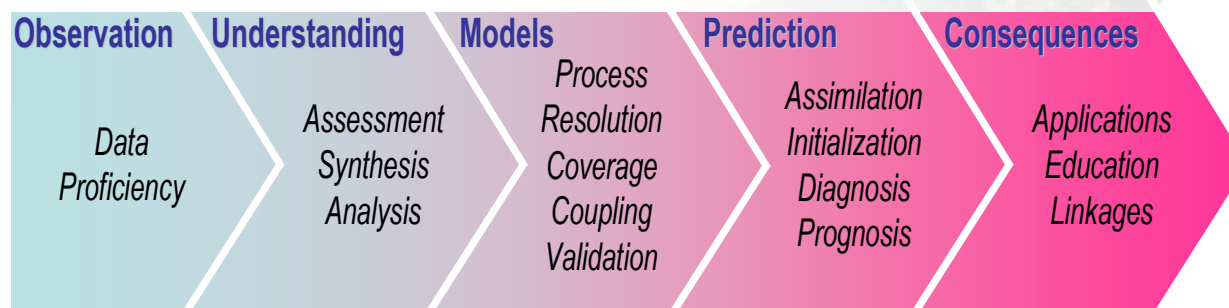
Air Quality



# NEWS Integrated Water and Energy Cycle Research

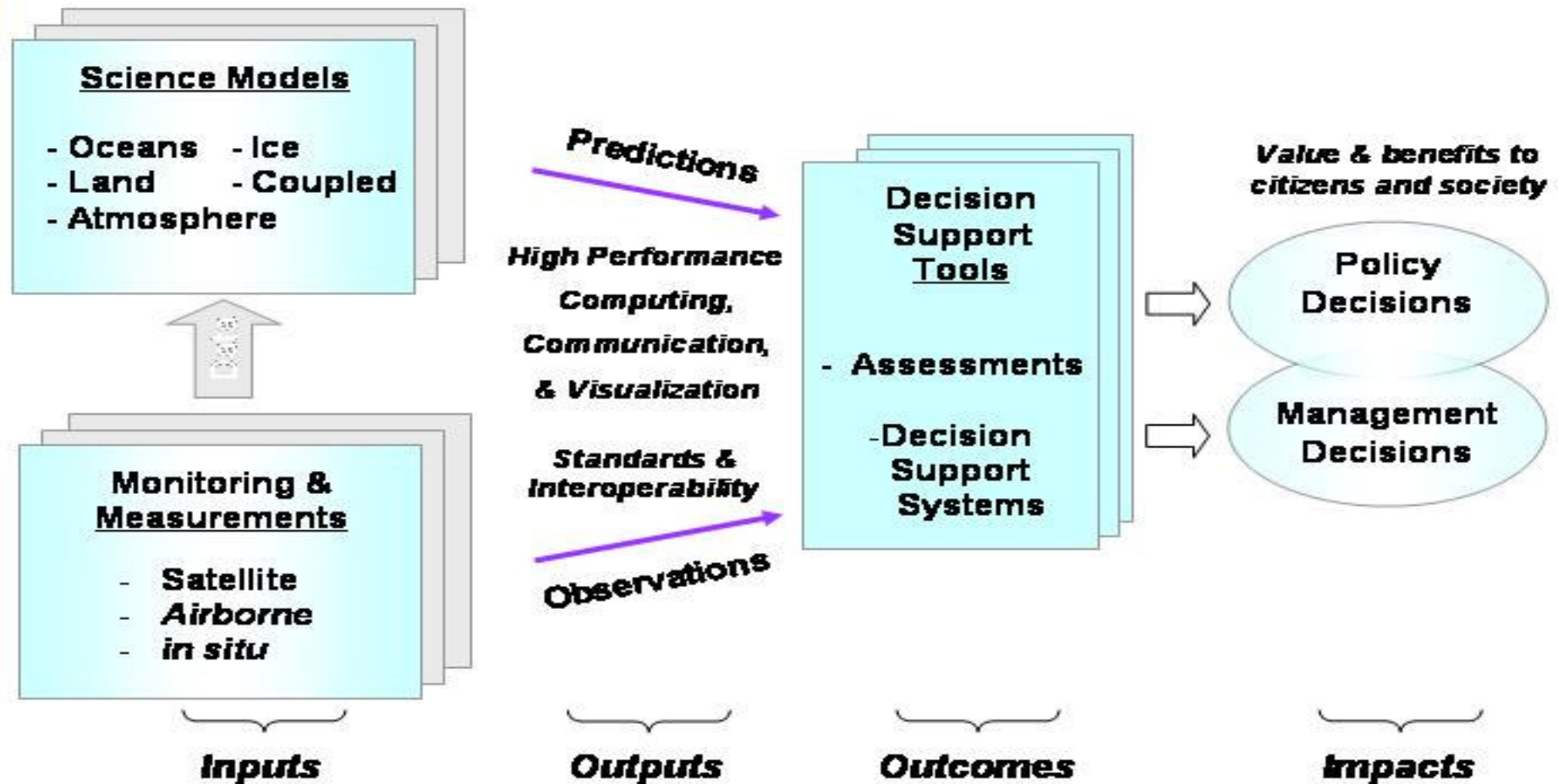
## From Observations to Consequences

The NEWS challenge is **global** in scale and requires the integration of NASA **system components** to **make decisive progress toward the NEWS challenge** in an **end-to-end program**

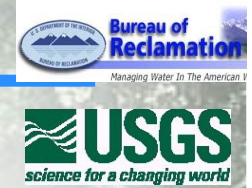
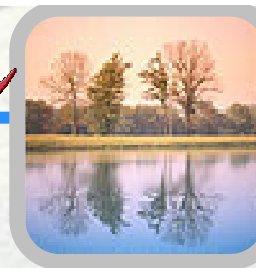
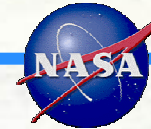


# NASA Applications Program Approach

## Solutions: Science to Decision Support



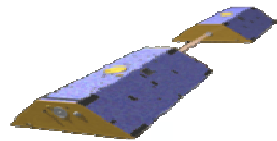
# Strategy 1: NASA Water Management Strategy



**Terra**



**GRACE**

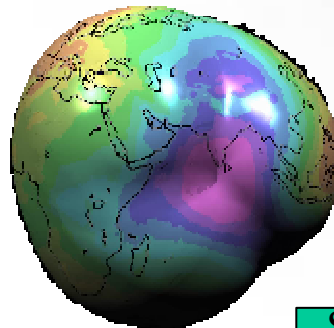


Processing

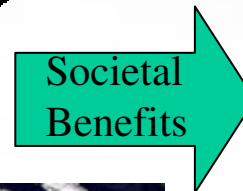


**EOSDIS & DAACs**

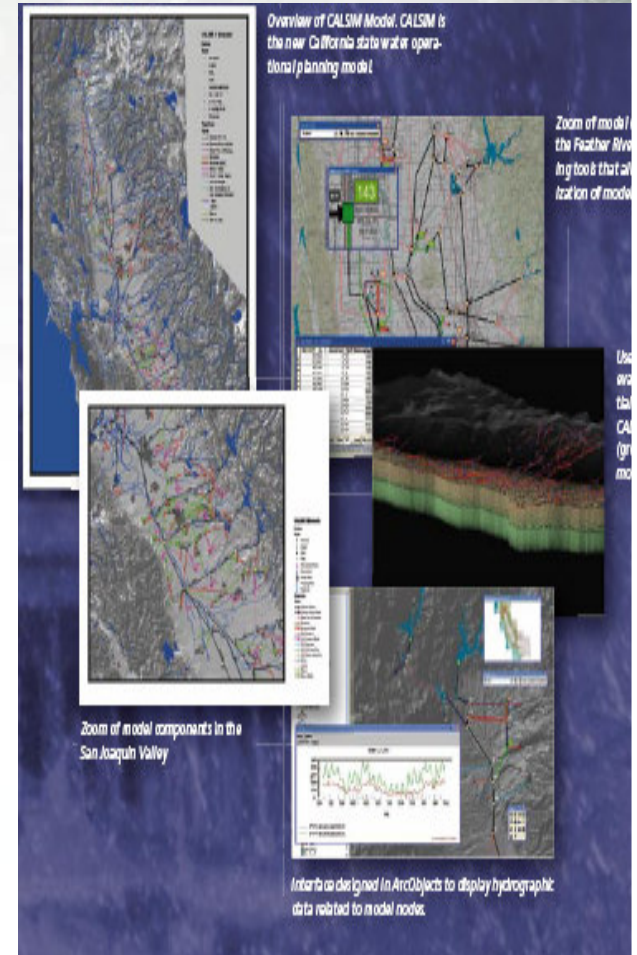
Exploitation



Societal  
Benefits



**Data Assimilation  
& Modeling**

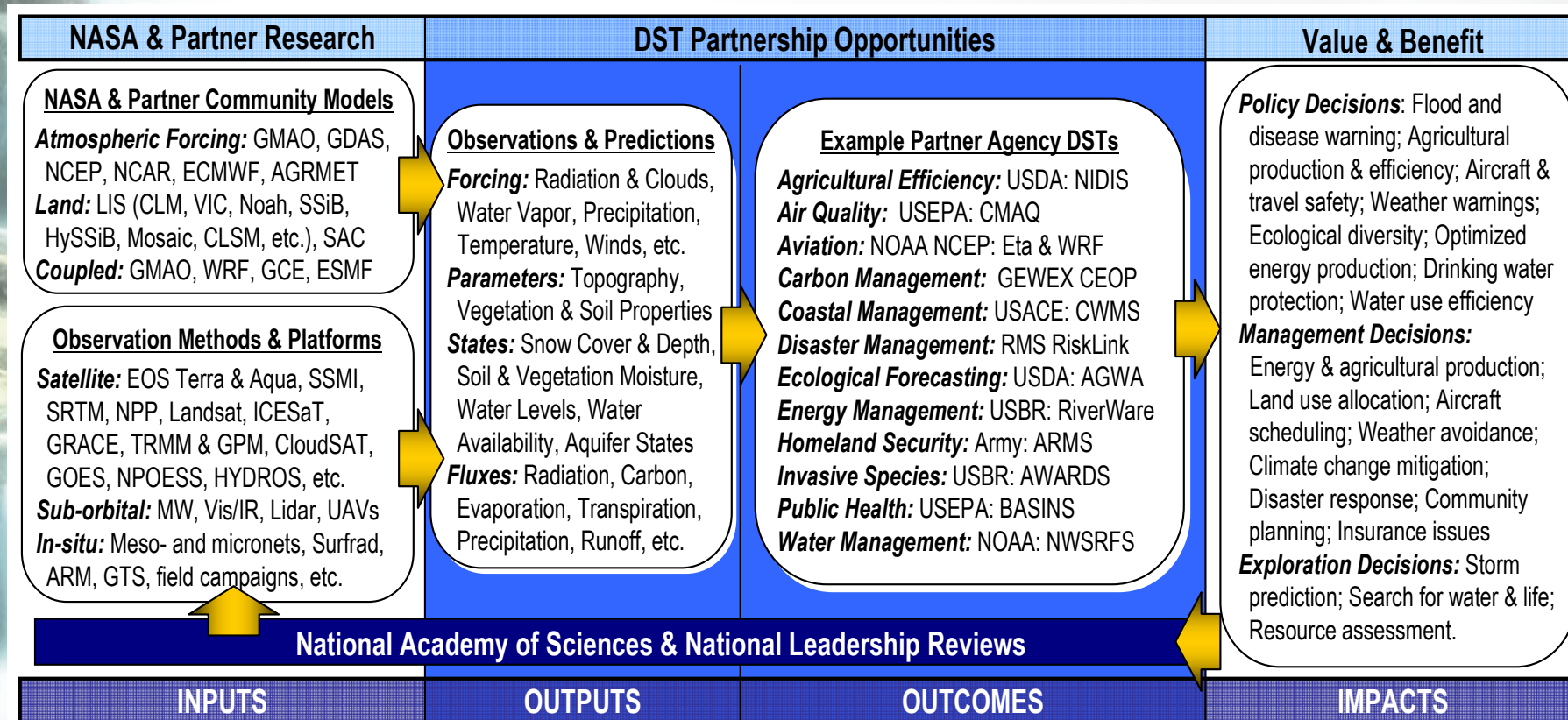


**Riverware  
& AWARDS**

## Strategy 2: Integrated Systems Solutions

Develop the required integration between research products and end-user solutions using a **modeling and analysis system**:

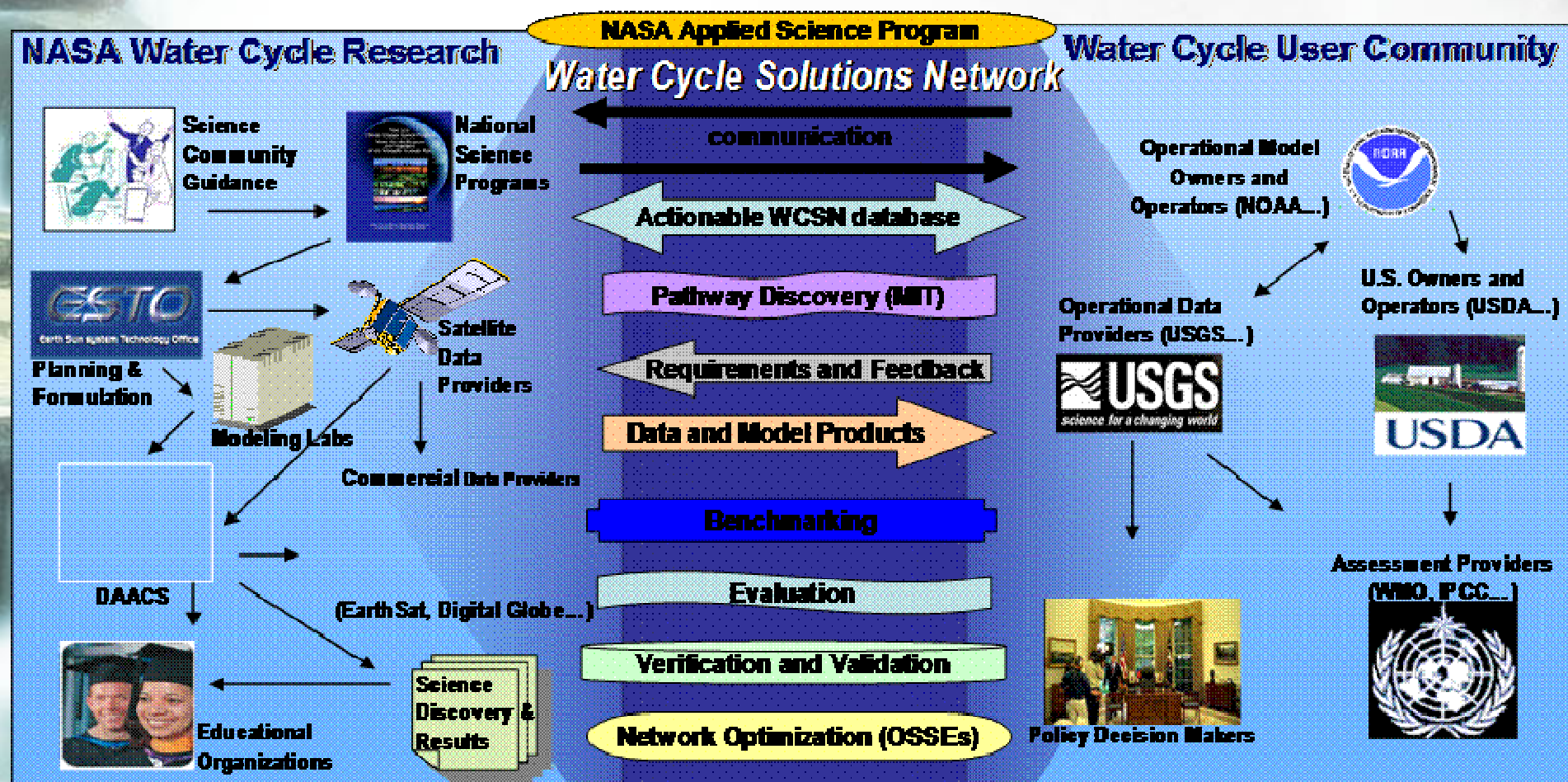
- Customize, **develop and test** modeling & analysis tools for use in specific DST solutions
- Demonstrate** prototype solution in partnership with end-user: manage data, generate runs, make data available to users
- Maintain** software, data, and visualization tools up-to-date, and answer user inquiries
- Analysis, optimization, **benchmarking**, evaluation and verification, of prototype solution
- Document**, communicate, and disseminate.



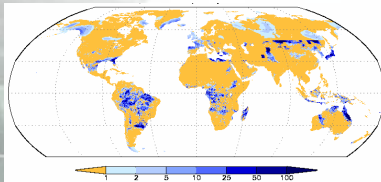
## Strategy 3: Solution Networks

***“A Water Cycle Solutions Network” was approved by NASA on June 3, 2005, to establish pathways and partnerships between NASA’s water cycle research investments and decision support needs.***

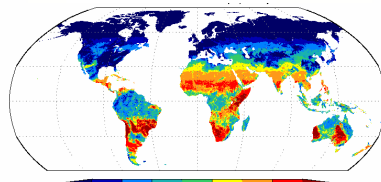
1. ***Evolve a network of partners:*** identify and analyze partner organizations to define collaboration pathways.
2. ***Routinely identify, prioritize, mine and communicate relevant research products and results.***
3. ***Optimize water cycle partner access*** to research results and products to create a self-sustaining network.
4. ***Analyze and document*** the network effectiveness through metrics, resource estimates and documentation.
5. ***Education and outreach*** is important to help society understand and use the research in every-day application.



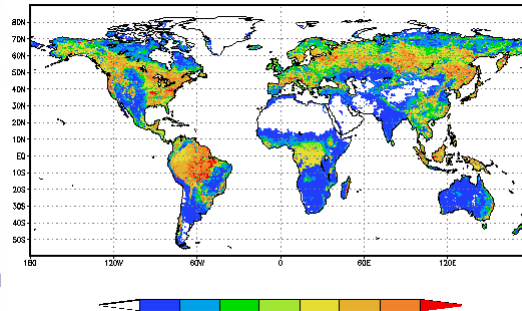
# Case 1: Land observations leading to improved climate prediction (M. Rodell)



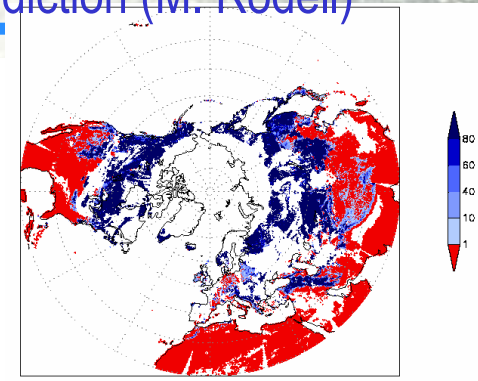
TRMM & IR total precipitation [mm]



Geostationary satellite daily mean downward SW radiation [W/m2]

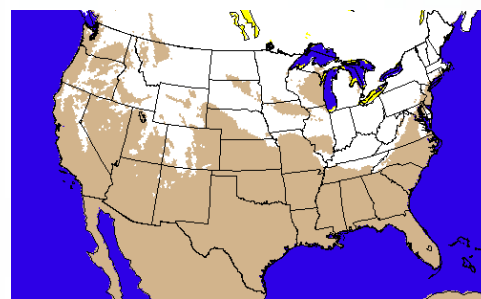
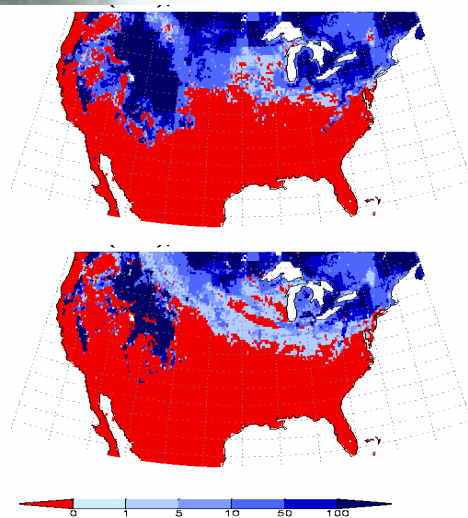


MODIS derived leaf area index



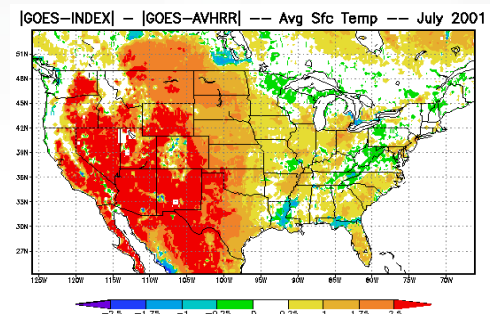
MODIS snow cover [%].

## ...RESULTS IN IMPROVED MODEL SIMULATIONS...

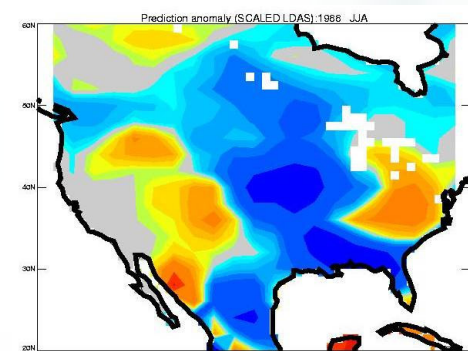
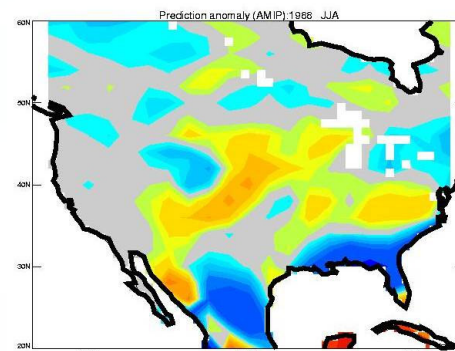
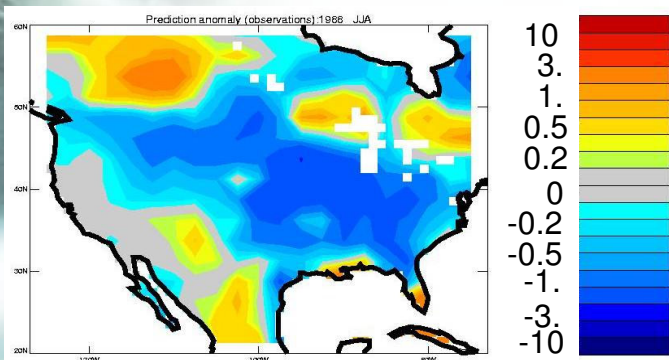


### Model assimilation:

LIS/LDAS snow water equivalent [mm] without (far left top) and with (far left bottom) assimilated MODIS snow cover; IMS snow cover "truth" (near left), 20 Jan 2003. Improvement in modeled surface temperature [C] when MODIS leaf area index is incorporated into the land surface model (right).



## ...AND LEADS TO MORE ACCURATE PREDICTIONS.



Seasonal forecast model initialization: JJA 1988 observed seasonal precipitation anomaly [mm/day] (above left); NSIPP model prediction without (above center) and with (above right) LDAS initial soil moisture [Koster et al., 2003]

# Possible application benefits from implementation of NEWS.

<b>WEATHER &amp; CLIMATE</b>	
<b>Short Term Weather Prediction</b>	<ul style="list-style-type: none"> <li>• Establish warning system for extreme event forecasting, floods and hurricanes.</li> </ul>
<b>Seasonal to Interannual Changes to water cycle</b>	<ul style="list-style-type: none"> <li>• Improve short term forecasts and decision support systems.</li> <li>• flora and fauna distributions, energy planning.</li> </ul>
<b>Anthropogenic Impacts</b>	<ul style="list-style-type: none"> <li>• Assess Anthropogenic impacts to water and energy cycle.</li> </ul>
<b>BIOGEOCHEMISTRY</b>	
<b>Carbon Cycle</b>	<ul style="list-style-type: none"> <li>• Study and develop links with water and energy cycle.</li> </ul>
<b>Other Nutrients (e.g., nitrogen)</b>	<ul style="list-style-type: none"> <li>• Link water availability with nutrients for air and water quality.</li> </ul>
<b>HUMAN IMPACTS</b>	
<b>Water Quality</b>	<ul style="list-style-type: none"> <li>• Improved water science/availability for assessments (e.g.,</li> </ul>
<b>Infectious disease</b>	<ul style="list-style-type: none"> <li>• For the development links (e.g., dry) using remote sensing.</li> </ul>

# Application benefits from implementation of NEWS (Cont'd).

<b>ECOSYSTEMS</b>	
<b>Coastal Areas</b>	<ul style="list-style-type: none"> <li>• Assess changes to coastal areas from water cycle, sea level</li> </ul>
<b>Sea Level Rise</b>	<ul style="list-style-type: none"> <li>• <del>improved estimates</del> <b>improved estimates</b> of glaciers and ice sheets.</li> <li>• Study water budget, continental and ocean mass.</li> </ul>
<b>Agriculture</b>	<ul style="list-style-type: none"> <li>• Improve assessment and prediction of food production and</li> </ul>
<b>Flora and Fauna Distributions</b>	<ul style="list-style-type: none"> <li>• <del>Water and energy cycle</del> <b>Water and energy cycle</b> changes critical future changes to</li> </ul>
	flora and fauna distributions
<b>WATER</b>	
<b><u>AVAILABILITY</u></b>	<ul style="list-style-type: none"> <li>• Provide local to global estimates for closing water budget.</li> </ul>
<b>Snow and Ice</b>	<ul style="list-style-type: none"> <li>• <del>Link to redistribution of energy through global heating.</del> <b>Link to redistribution of energy through global heating.</b></li> <li>• Develop techniques for snow water equivalent</li> </ul>
<b>Ground Water</b>	mapping estimates via GRACE and indirect estimates via
<b>Surface Runoff</b>	<ul style="list-style-type: none"> <li>• <del>Modeling and remote sensing</del> <b>Modeling and remote sensing</b> gauged basins.</li> <li>• Indirect (distributed modeling &amp; direct (remote</li> </ul>
<b>Soil Moisture</b>	sensing) <b>sensing</b> from experimental to operational estimates.

# Summary

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## **End-user decision support & solution network connections (NEWS Consequences):**

- Understand and document end-user requirements.
  - Develop database of NEWS data/model capabilities.
  - Develop pathways to connect DST's to NASA WEC capabilities.
  - Develop links to the Water Cycle Solutions Network (WCSN)
  - Customize NEWS products or develop new products that are responsive to WCSN identified end user needs.
- 
- The NEWS consequences component is not well established
  - Consequence of NEWS being a science program
  - Must establish strong links with the applied sciences components of NASA.